5-1-2012

THE ROLE OF PHONOLOGY AND SEMANTICS IN THE LEXICAL PROCESSING OF ASL CORE LEXICAL ITEMS AND CLASSIFIER CONSTRUCTIONS

Jeannine Kammann

Jeannine Kammann
Candidate

Linguistics
Department

This thesis is approved, and it is acceptable in quality and form for publication:

Approved by the Thesis Committee:

Prof. Jill P. Morford, Chairperson

Prof. Phyllis Perrin Wilcox

Prof. Barbara Shaffer

The role of phonology and semantics in the lexical processing

of ASL core lexical items and classifier constructions

BY

Jeannine Kammann

B.A., Linguistics

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Master of Arts

Linguistics

The University of New Mexico
Albuquerque, New Mexico

May, 2012

ACKNOWLEDGMENTS

"As a single footstep will not make a path on the earth, so a single thought will not make a pathway in the mind. To make a deep physical path, we walk again and again. To make a deep mental path, we must think over and over the kind of thoughts we wish to dominate our lives."

~ Henry David Thoreau ~

Wow, what a journey. When I decided to leave Germany in 2004 for four months to reconsider my studies, who would have thought that almost eight years later this was going to happen?

I am thankful to my sisters, Sandy and Jessica, as well as my nephews, Jeremy and Leo for their support. Though I have not been home in too many years and I missed the boys growing up, they somehow understood my choice of path.

As I was struggling to get to the right place, physically, mentally, and emotionally, to where I was ready and able to write this thesis, I was fortunate to be adopted into the hearts and home of Vera and Tim Kleinhenz, who have taken on parental roles in all their facets. Thank you for providing me with a place to feel and call home. Thank you for letting me write in your house and offices. And thank you for countless meals you have provided me. Without your endless support, trust, and love this would not have been possible. Thank you, Mom and Dad!

My deepest and most sincere thank you to Prof. Jill Morford, who has been a constant supporter since we met in 2007. I believe Jill saw something in me early on that I still need to get used to seeing in myself. Through the years Jill has been an amazing mentor. I am glad and honored to work with you. Danke! Another huge thank you to Prof. Phyllis Wilcox who always has a warm smile on her face and always wanted to know more about my interests and then sparked new ideas. A big thank you to Prof. Barb Shaffer who joined us on this journey and was full of support and knowledge. I also extend my thanks to Prof. Melissa Axelrod who always had an open ear and heart and who was always supportive, even when I lost faith in myself.

Thank you to James MacFarlane whose "fault" it is that I chose to major in Linguistics. Thank you, Jim. To Dr. Dawn Nordquist and Dr. M, Dr. David Margolin, who alongside Jim MacFarlane were the first Linguistics instructors who taught me after I moved to Albuquerque. Both of them were always full of excitement and wanted to hear more about my work and interests.

I would also like to thank Prof. Sherman Wilcox, Prof. Caroline Smith, Bonnie Rudy, the staff and faculty of the Linguistics Department and Sign Language Program.

I am thankful to Benjamin Anible, Orlando Obeso, Corrine Occhino-Kehoe, and Bry Burns, who were in on this study from day one. Without your hard work, enthusiasm, knowledge, and dedication, this would not have happened. Bry Burns' image was used with his permission. Thank you, Bry! Also thanks to my fellow Linguistics grad students. I would also like to acknowledge the contribution of the individuals, deaf and hearing, who agreed to participate in this study. Without their involvement, this opportunity for learning would not have been possible.

I would like to thank the members of Expressions of Joy, The Albuquerque Civic Chorus, and The Asbury UMC Chancel Choir who provided me with support through their music. Thanks also to CAPS and my students, who also taught me a lot. Lastly, my sincere appreciation goes to the staff and teachers at the New Mexico School for the Deaf.

THE ROLE OF PHONOLOGY AND SEMANTICS IN THE LEXICAL PROCESSING OF ASL CORE LEXICAL ITEMS AND CLASSIFIER CONSTRUCTIONS

by

Jeannine Kammann

B.A., Linguistics, University of New Mexico, 2010

M.A., Linguistics, University of New Mexico, 2012

ABSTRACT

This MA thesis explores lexical processing in American Sign Language (ASL). Although a model of lexical processing exists for spoken languages, the research on lexical processing, storage, and organization in signed languages is not very extensive and has been focused on the core lexicon. The present study, for the first time, investigates the role of classifier constructions in ASL lexical processing. Classifier constructions form an essential part of the sign language lexicon, but have previously not been the foci of psycholinguistic studies. The present study compares processing of classifier constructions, with that of core lexical items and nonce signs with the help of a phoneme monitoring task. This task was performed by two participant groups: Deaf signers and hearing non-signers.

An interaction of phonology and semantics was observed. Classifier constructions are processed differently than core or nonce signs in signers. Differences in processing time for classifier constructions vs. core signs are interpreted as a reflection of the fact that the meaning of a classifier construction cannot be anticipated prior to completion of the sign movement. Additionally, signers' responses to classifier constructions were slower than responses to nonce signs, suggesting that signers not only wait for the end of the movement, but then also have additional processing load of integrating classifier constructions with prior semantic context. Non-signers completed the task as rapidly as signers but did not display a difference in reaction times for the different sign types, which rules out the possibility that form differences such as sign complexity or sign duration were responsible for the differences observed in the Deaf signers' performance.

TABLE OF CONTENTS

ABSTRACT ….. **vi**

LIST OF FIGURES .... **x**

LIST OF TABLES .... **xi**

CHAPTER 1 INTRODUCTION **1**

CHAPTER 2 LEXICAL ACCESS …... **3**

CHAPTER 3 PREDICTIONS …... **5**

CHAPTER 4 THE EXPERIMENT …... **9**

4.1 Phoneme Monitoring 9

4.2 Methodology 9

4.2.1 Participants ….. 9

4.4 Recruitment ….. 11

4.5 Materials ….. 12

4.6 Apparatus …... 15

4.7 Procedure 16

4.8 Coding ….. 20

CHAPTER 5 RESULTS ….. **21**

CHAPTER 6 DISCUSSION ….. **25**

APPENDICES …... **29**

APPENDIX A Core Signs …... 29

APPENDIX B Classifier Signs …... 30

APPENDIX C   Nonce Signs ….. 31

APPENDIX D   Background Questionnaire …... 32

REFERENCES ….. 34

LIST OF FIGURES

Figure 1. Selected Handshapes …... 13

Figure 2. Reaction Times to Three Sign Types by Deaf Signers and Hearing Non-Signers ..…... 22

LIST OF TABLES

Table 1. Participants ….. 11

Table 2. Sign Examples per Handshape in Core, CLCs, and Nonce Signs …................. 15

Table 3. Order of Handshape Presentation ….. 16

Table 4. Response Messages …... 17

Table 5. Accepted Allophonic Variations of Handshapes …... 19

Table 6. Reaction Times per Group by Sign Type ….. 22

Table 7. Accuracy per Group by Sign Type ….. 23

Chapter 1

Introduction

The goal of studies on lexical access is to broaden our understanding of lexical representation, organization, storage, recognition, processing, and access. It is crucial to understand how linguistic forms and the mental lexicon interact. While there are models for spoken languages, there are no formal models for languages in the visual modality. A common tool to investigate lexical processes in spoken languages is a phoneme monitoring task (for a review see Connine & Titone, 1996). This task has only recently been modified for signed languages (Corina & Hildebrandt, 2002; Grosvald et al., 2012; Morford & Carlson, 2011). Most if not all studies on signed languages focus on non-productive monomorphemic signs. Yet, productive multimorphemic signs make up a significant part of signed language lexicons. Linguistic descriptions of signed languages identify classifiers (CLs, hereafter) as a central structure; however, psycholinguistic studies systematically exclude classifier constructions from the stimuli used in experimental contexts. CLs and classifier constructions (CLCs, hereafter) have not been investigated much in signed language research, and not at all to this point in studies of lexical access. Therefore, we have very little knowledge about how CLs are recognized and processed. The present study examines, for the first time, the lexical access of American Sign Language (ASL) classifier constructions with the help of a phoneme monitoring task.

Many languages, regardless of modality, use CLCs. A classifier, in general, is defined as “a word or morpheme used in some languages in certain contexts (…), that indicates the semantic class to which an item belongs” (free dictionary). In signed languages CLCs are used to express specific relationships of the following four parameters: location, motion, size, and shape.

Classifier constructions in ASL, as proposed in the 1970s by Ted Supalla, are used to show movement, location, and appearance (Supalla, 1978). Additionally to movement and location, Emmorey (2002) notes stative-descriptive and handling information as instances when classifier constructions gain importance. Furthermore, they “denote figure, ground, and secondary reference objects” and “[t]he movement and location of the hands in signing space can schematically represent the motion and location of objects in the world in an isomorphic fashion” (Williford, 2008; Emmorey 2002, respectively).

For this study, sign selections were based on Brentari's (1998) categorization of signs, and belong to either one of two lexical categories; core lexicon, including forms that have originated from the classifier predicate[1] system or from fingerspelling after which they have been lexicalized to conform with native phonological constraints, and classifier predicates*,* polymorphemic entries made up of bound roots and various affixes. Brentari also includes a third category of signs, fingerspelling; however, this category will not be investigated in the present study. These categorizations are important distinctions to make because the degree to which phonological constraints act on each class varies, as do the forms’ relationship with its iconic properties. Further, this study compared lexical access of core and CL signs to nonce signs to investigate how semantics impacts lexical access.

1 *Classifier predicate* is used here in order to follow Brentari's terminology.

Chapter 2

Lexical Access

Lexical access models are crucial for us to understand how lexical items are represented, organized, stored, recognized, processed, and accessed. “Lexical access is concerned with how (…) input of language is projected unto the mental representations of lexical forms” (Carreiras et al., 2008). Studies have mostly been based on spoken languages. In spoken languages word onsets activate multiple potential candidates for the uttered word. Once the phonological information does not match the competing lexical candidates anymore, these candidates become deactivated until only the intended word is recognized.

For signed languages, however, there is no mutually agreed upon model. Few studies have been undertaken to gain a broader knowledge on the sign language mental lexicon (Grosjean, 1981; Clark & Grosjean 1982; Emmorey & Corina, 1990; Emmorey, 2002; Carreiras et a., 2008; Morford & Carlson, 2011, and others). In spoken languages lexical access is influenced by lexical frequency and phonological similarities to competing lexical candidates (compare Carreiras et al. 2008). Carreiras et al. found indications that accessing signs could be similarly based on these two factors. However, their findings indicate that the different phonological parameters have different influences during the process of sign recognition. In general they found that the order in which the phonological parameters are recognized is location, orientation, handshape (HS), and much later movement, as this unfolds over time. Similarly, in their gating study, Emmorey and Corina (1990) found that location and HS are recognized earlier than movement: “ASL phonological information signaling Location, Orientation, and Handshape is enough to isolate a set of morphological variants. (…) the isolation of Movement leads directly to lexical identification, whereas in speech there is no phonological element that corresponds as strongly with word identification” (Emmorey & Corina, 1990, p. 1250). Since movement unfolds over time in sign, once the movement is completed and therefore recognized, the sign is entirely isolated. Morford and Carlson (2011) conducted a gating study and found that non-native signers are over-reliant on HS during sign recognition. Non-native signers identified target HS first, while native signers identified target HS and location first simultaneously. Thus their results suggest that language experience influences sign identification processes, as well.

Grosjean conducted several gating studies, first on spoken language and later on signed language. In 1980 Grosjean conducted a gating study on spoken word recognition. He, like researchers after him, points to frequency effects: “High-frequency words are processed more accurately and more rapidly than low frequency words” (Grosjean, 1980, p. 267). In 1982 Clark and Grosjean conducted another study. Based on the 1980 study, they implemented the gating task on the visual modality to study sign recognition in ASL. They found that about 50% of a sign was required to isolate the sign itself. Grosjean's studies show that participants need to strongly rely on context and semantics to identify the target words and signs.

These studies have produced what we currently know about lexical access in signed languages. However, findings pertain only to the core lexicon.

Chapter 3

Predictions

In a phoneme monitoring task it is not necessary per se to access the lexicon in order to respond to whether a HS was present or not. However, past studies of using the phoneme monitoring task with spoken language stimuli suggest that participants typically do access meaning when monitoring for phonemes. Thus, the assumption for the present study is that Deaf[2] participants will access the semantics of what is shown to them and not only monitor for HS. The Deaf participants will not inhibit comprehension of the stimulus sentences. This allows us to use response latencies as a measure of the difficulty involved in processing different types of signs: CL signs, core signs and nonce signs.

The use of CLCs is different from core lexical items. The core lexicon is a closed class. However, there are unlimited ways in which to combine these items into utterances. With the help of context, signers can anticipate which signs may be used, but they cannot completely rule out other candidates. CLCs are highly unique every time they are produced, as there are unlimited possible combinations in which a CL HS and the surrounding construction may occur. Therefore, the meaning of CLCs are not conventionalized, but rather interpreted relative to context. Depending on genre, CLCs are used more or less frequently. Morford & MacFarlane (2003) found CLCs to occur in 4.2% of their corpus of 4100 signs transcribed from commercially available videotapes of ASL. When taking a closer look at narratives only, they found 17.7% of the signs used were CLCs. Similarly, in her dissertation, Williford (2008) used a collection of ASL

2 The capitalization of *Deaf* is used as participants are members of the Deaf community

narratives from the National Center for Sign Language and Gesture Resources (NCSLGR), located in Boston. She found that 7.68% of the signs were CLCs.

As described above, HS, orientation and location of signs are recognized and isolated first in lexical processing. Movement unfolds over time in all sign types. Movement in CLCs is no different; it is not available in the beginning of the construction. Studies have shown that the parameter of movement is the last parameter identified in lexical recognition and therefore leads to complete isolation of a sign and its meaning. For both sign types, HS and location are immediately available at the onset of the sign. For CLCs the location here relates to the initial location of the construction, which will change as the movement unfolds. Hence, location for CLCs is not entirely predictable, which leads to the hypothesis that CLCs will be accessed more slowly than core signs. More specifically, the hypothesis is that HSs in CLCs will be detected more slowly than HSs in core signs.

Why should we expect a difference in reaction time when the task is to merely monitor for a HS? For ASL signers it is expected that they will analyze the utterances not only on the phonological level, but also on the semantic level. This, in turn, will lead to delayed responses to the task. To address this, non-signers will also be recruited to complete the task. Since the non-signers have no knowledge of ASL or any other signed language, they cannot access the semantic level. If they show no difference in reaction time (RT) to the different sign types, then we can conclude that any differences are related to lexical properties rather than superficial phonetic differences.

For both of the groups, Deaf signers and non-signers, in order to complete the phoneme monitoring task, no access of the meaning of the presented sentences is necessary. The non-signing participants will not access semantics of the presented sentences, as they have no knowledge of any signed language. Hence, for the non-signers there will be no interaction of phonological and semantic processes. They will solely monitor for the HS they are asked for. If the Deaf participants perform the task like the non-signers, then no difference in processing will be observed. However, for the Deaf participants, it is predicted that they will not inhibit their natural language processing when mapping form onto meaning. Thus, there will be an interaction of semantics and phonology for this group. This will lead to delayed responses and longer reaction times compared to the non-signers.

Looking at sign types, Grosvald et al. and past researchers have found "faster RTs (reaction times) in the context of words than in non-words" (Grosvald et al., 2012). This is also to be expected in this present study. This is related to frequency and the order of recognition of sign parameters. Nonce signs are, of course, not signs the signers are accustomed to, as they are phonologically possible but nonexistent. Sign recognition is based on HS, orientation, and location of the signs first before complete isolation by recognition of movement. The first three parameters will not help in sign identification of nonce signs, so it is necessary to wait until movement unfolds to isolate nonce signs, at which point signers will still not recognize the signs, as they do not exist. This then, also, leads to a delayed response, and therefore a longer RT for signers, but not for non-signers.

The same process of sign recognition takes place for core signs. Participants are familiar with these signs, and will be able to isolate the signs when they are presented with the HS, orientation, and location of the sign, and will not need to wait for the unfolding of movement. HS is usually presented early in the sign formation and held throughout. Therefore it is to be expected that RTs for core signs are faster than for nonce signs.

This is the first study including CLCs, so any hypotheses regarding this sign type are novel ideas. Assuming that lexical processes involving CLCs are similar to the processes involved with nonce signs, delayed RTs can also be expected here. Since CLCs do not display the frequency as core signs do, it is assumed that the processes for CLCs are less similar to the core signs, than to the nonce signs. Signers will display an interaction of phonology and semantics. Hence, participants would have to wait until the movement unfolds until they respond to the monitoring task, similarly to the wait for the unfolding for nonce signs.

In sum, the following results in RTs are expected: Deaf signers will display differences in RTs between the different sign types; core signs will be isolated the fastest, then nonce signs, followed by CLCs. Furthermore, the present study will be able to determine whether there are differences in semantic processing of core versus CL signs using the monitoring task.

Chapter 4

The Experiment

4.1 Phoneme Monitoring

Phoneme monitoring tasks are used widely in spoken language studies to investigate language processing (as reviewed by Connine & Titone, 1996). There are a few signed language studies that used this task (Corina & Hildebrandt, 2002; Morford & Carlson, 2011; Grosvald et al., 2012). This task “has been instrumental in motivating discussions of the relative importance of autonomous versus interactive processes in language comprehension” (Grosvald et al., 2012, p. 119). These studies show significant evidence of interaction of phonology and semantics during lexical access. This present study will be able to determine whether there are differences in semantic processing of core versus CL signs using the monitoring task.

4.2 Methodology

4.2.1 Participants

This study investigates lexical processing of two groups: Deaf ASL signers, as well as hearing non-signers. A total number of 24 participants took part in the study; 14 Deaf ASL signers and 10 hearing non-signers. For the group of Deaf participants there were 9 women (64.3%) with an average age of 35.5 years (24 – 50 years of age). The average age of ASL acquisitions was 4.85 years (from birth – 23 years of age). The average amount of ASL experience is 29.5 years (22 – 48 years). The hearing non-signer's group was comprised of 8 women (80%), whose average age was 24.2 years (18 – 48 years of age). For the groups' education levels, please see Table A below. The Deaf participants reported their hearing loss to be 80dB or greater in the better ear.

Participation was voluntary. Participants were either compensated monetarily or received course credit. All participants gave informed consent before participating in the study and were informed that they were free to withdraw from the study at any time. An ASL translation of the consenting materials was offered to Deaf participants. Besides performing the Phoneme-Monitoring task, Deaf participants were asked to complete the ASL Sentence Repetition Task (ASL-SRT) and complete a language-background questionnaire (see Appendix D).

TABLE 1.

Participants

	Deaf Signers	Hearing Non-Signers
# of Participants	14	10
# of Females (%)	64.3%	80%
Average Age (yrs.)	35.5 (24 – 50)	24.2 (18 – 48)
Average age of ASL acquisition (yrs.)	4.85 (from birth – 23)	N/A
Average of ASL experience (yrs.)	29.5 (22 – 48)	N/A
Highest Educational Level Completed*	HS: 1 BA/ BS: 3 Grad. Studies: 9 No Info.: 1	HS: 10 BA/ BS: 0 Grad. Studies: 0
ASL – SRT score	Average: 13.55 σ = 4.13 Range [8, 20]	N/A

* HS – High School Degree; BA/ BS – Bachelor's Degree; Grad. Studies – Graduate Studies, No Info. – No information was provided.

4.2.2 Recruitment

Recruitment flyers were distributed at the following locations: the Deaf Cultural Center in Albuquerque, New Mexico (DCC); the New Mexico School for the Deaf in Santa Fe, New Mexico (NMSD); Deaf community events. Linguistic 101/ Anthropology 110 students of the University of New Mexico (UNM) were recruited through email to their instructors and class announcements. Data collection was executed at UNM and NMSD.

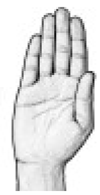
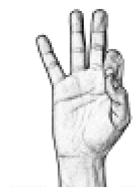
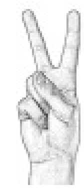
4.2.3 Materials

The stimuli consisted of 48 target signs (16 core signs, 16 CL signs, 16 nonce signs) in signed sentences. Target signs were selected by crossing four HSs with three sign types: classifier signs, core signs, and nonce signs. The four ASL HSs were selected as target stimuli based on their ability to be used in multiple classifier constructions (CL) as well as the core lexicon of ASL. Of the four HSs, two were unmarked (B, 1) and two were marked (F, V). Images of the HSs can be found in Figure A below[3]. The experiment is divided into three conditions: Core signs, CLCs, and nonce signs. Each condition is tested across the four HSs (B, 1, F, V). 96 filler sentences were created to balance target sentences, used sporadically throughout each block of the experiment; 24 filler sentences per HS. Filler sentences did not include any instances of the four target HSs.

3 Images from: www.lifeprint.com

Figure 1.

Selected HSs

B	1	F	V
			

The core lexical items were selected using multiple dictionaries of ASL (Tennant & Brown, 1998; Bailey & Dolby, 2002), restricting the signs to one-syllable constructions with no hand-internal movement and no sign-internal hand configuration change. Both two-handed, symmetrical and asymmetrical, and one handed signs were included (for full lists of signs by sign type, see Appendices A – C).

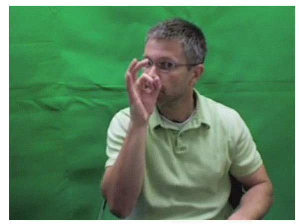
A Deaf ASL consultant helped to select classifier predicates which adhere to phonotactic and semantic constraints. The consultant teaches ASL and Deaf Studies at UNM and is an active member of the American Sign Language Teacher Association.

Due to the nature of classifier predicates and their use, it was necessary to place all of the stimuli in contextually appropriate phrases. Thus, all stimuli, both core lexical items and classifier predicates, were presented in sentences. In the construction of sentences, the target HSs did not occur in any signs before the target sign. All sentences were controlled for length. Core target sentences were restricted to four to six signs and CL sentences were restricted to six to eight signs. CLCs are anaphoric and therefore require a longer sentence onset. Thus, stimulus sentences containing CLCs were longer than sentences for core and nonce signs. The target sign could occur any place except for the first sign in a sentence. Position in the sentences was balanced so that targets were seen equally in second to last position in each condition.

In order to control for lexical effects, a group of nonce signs was included. Nonce signs were all permissible but non-occurring signs in ASL. In other words all nonce signs are phonological possible and not impossible to produce. The selection of these signs was based on actual ASL signs that are not produced using one of the target HSs. The HS of the actual signs were changed to match the target HS of this study (e.g., COFFEE produced with HS- 1-1). Nonce signs were also included in sentence contexts in positions where the sign which was manipulated to create the nonce sign would have been syntactically appropriate. Semantic effects were controlled by excluding semantically related signs to the target signs. No signs that are similar or close in meaning to the target signs were used prior to the target signs in the sentences. This prevented priming of the target signs.

Table 2.

Sign Examples of F HS in Core, CLCs, and Nonce

Sign Type	Gloss	Picture
Core	JUDGE	
Classifier	CL: F "nose will grow"	
Nonce	N/A	

4.2.4 Apparatus

A Deaf fluent ASL signer was recruited to produce the ASL sentences. The sign model has been exposed to ASL since age three and has a total of 38 years of experience using ASL. All stimuli were recorded with an internal "Apple iSight webcam" using complementary metal oxide semiconductor active pixel sensor (CMOS APS). Video was captured and edited with "iMovieHD," version 6.0.3. Video clips were then compressed to 15 frames per second (fps) at 320 x 240 pixels. They were then converted to ".mp4" format using "Handbrake," version 0.9.5.

4.2.5 Procedure

A phoneme monitoring task was designed using E-Prime[4]. To avoid confounds due to ordering of marked versus unmarked HSs, four different versions of the experiment were designed varying the order in which the block of the different HSs were presented.

Table 3.

Order of HS Presentation

Name of Test	HS Order	Block 1	Block 2
Phoneme Monitoring 1	F, B, V, 1	Marked, Unmarked	Marked, Unmarked
Phoneme Monitoring 2	B, 1, F, V	Unmarked, Unmarked	Marked, Marked
Phoneme Monitoring 3	F, V, 1, B	Marked, Marked	Unmarked, Unmarked
Phoneme Monitoring 4	1, V, B, F	Unmarked, Marked	Unmarked, Marked

Each test was initiated by informing the participant of the experimental procedure including completion of informed consent, experiment, background questionnaire, and the ASL-SRT. This was performed verbally or signed by either the author or one of two fellow researchers. At the beginning of the experiment, directions state that the participant will be asked to perform a phoneme monitoring task that will require them to

4 http://www.pstnet.com/eprime.cfn

watch for the following HSs.

Practice blocks were designed, consisting of 15 practice trials each, to prepare and train the participants for the phoneme monitoring task. In the practice session, participants were told to press "ENTER" if they saw the S-HS, which was the target HS for the practice block. As part of their training, participants were presented with five different response messages, each for a different response type.

Table 4.

Response Messages

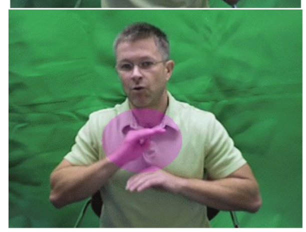
TARGET	"ENTER"	RESPONSE MESSAGE
Presented	Before	"OOPS YOU PRESSED ENTER TOO SOON"
Presented	No Response	"OOPS YOU MISSED THE HANDSHAPE"
Not Presented	Any time	"OOPS THE HANDSHAPE WAS NOT THERE BUT YOU SAID IT WAS"
Presented	After	"GOOD YOU SAW THE TARGET HANDSHAPE!"
Not Presented	No Response	"GOOD THE HANDSHAPE WAS NOT PRESENT!"

During this practice session participants received immediate feedback about their performance. Participants were required to achieve a minimum of 70% accuracy in order to move on to the actual experiment. If they did not achieve the minimum average, they were allowed up to three attempts to score above 70%. If they were not able to score above 70%, they did not proceed to the experiment.

The experiment was very similar to the practice section with the exception that there was no feedback given after the sentences. Participants were asked to watch for one HS at a time for four blocks, one for each HS (B, 1, F, V). Before each block, participants were reminded that sometimes the HS may vary slightly, but those variations would still count as correct instantiations of the target. This was included as part of what was displayed on the computer for the participants. At that time, participants were shown pictures of possible variations that could be found in that block. Each sentence was presented in succession, separated by a 1000ms transition slide. The transition slide was a blank white screen with a black fixation cross in the center of the screen. The instructions requested that the participants press “ENTER” on the keyboard if they recognized the HS within a sign in the sentence. It also requested for them to wait for the following sentence if they did not see the target HS. Upon completion of the experiment, the subjects were asked to fill out a background questionnaire that addressed issues of language preference, acquisition, as well as language use.

Table 5.

Accepted Allophonic Variations of HS

HS	Allophones
B	 
1	
F	
V	

4.2.6 Coding

Reaction time (RT) and accuracy were measured as the dependent variables. The first challenge was to synchronize RT measurements to the appropriate time in the video, since there is no clear break between signs. Signs are series of movements without a clearly distinct starting or end point. RT was measured from the onset of the transition between the prior sign and the target sign until participants responded. Sign onsets were calculated by two researchers, who achieved 93% agreement across measurements. If participants responded before the calculated onset of the target sign or after more than 4000ms after target presentation, those responses were deemed incorrect. Responses were coded for accuracy; only correct responses were analyzed for reaction time.

Chapter 5

Results

An ANOVA revealed a main effect of sign type on RT ($F(2, 44)= 4.05$, $p < .05$, $\eta^2_P = .16$). There was no main effect of group on RT. However, the effect of sign type was modulated by an interaction of sign type and group ($F (2, 44)= 3.84$, $p < .05$, $\eta^2_P = .15$, see Figure 2). Pairwise comparisons using Turkey's LSD revealed that RT differences across sign types were restricted to the Deaf participants only. Deaf participants responded faster when monitoring for HS in core signs than in CL signs ($p < .001$). Likewise, they responded faster when monitoring for HS in core signs than nonce signs ($p < .01$). Hence responses were fastest for core signs, followed by nonce signs, and CLCs, respectively. Looking at these RTs by group and sign type shows that for non-signers there are no significant differences in RTs. This suggests that there is nothing in the form of the signs that motivates a difference in responding. Deaf signers, however, display significant differences in RTs between the sign types, indicating that the way form is mapped to meaning in core signs versus CL signs does indeed impact lexical processing.

TABLE 6.

RTs (in ms) per Group by Sign Type

Sign Type	Deaf	Non-Signers	Mean
Core	998	928	963
CL	1137	928	1034
Nonce	1089	931	1009
Mean	1075	929	

FIGURE 2.

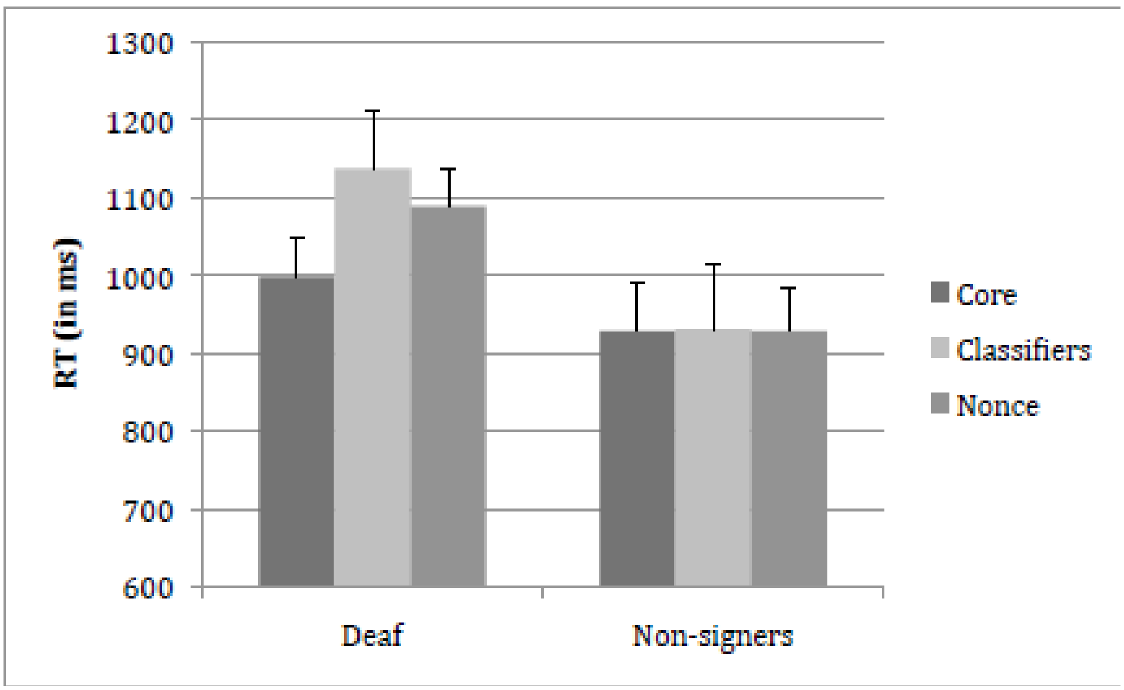


Figure 2: RT (in ms) to three sign types by deaf signers and hearing non-signers.

Accuracy in both groups was generally high (see Table 7). There were several main effects on accuracy. A main effect of group on accuracy could be observed ($F(1,22)= 15.19$, $p < .001$, $\eta^2_P = .41$), showing that Deaf participants' responses were more accurate than the non-signers' responses. This shows that being exposed to the modality improves one's ability to detect structural elements of signed languages. Additionally, there was a main effect for sign type ($F(2,44)= 34.58$, $p < .001$, $\eta^2_P = .61$), showing that all participants were better able to identify HS in CLCs and nonce signs than in core signs. More errors occurred for core signs, than for CL signs, or nonce signs. One explanation for this could be grammaticization of the items in the core lexicon. Lexical items that are used more frequently become subject to grammaticization. Once these items become grammaticized, they are often phonologically reduced, hence less clearly articulated. The higher level of frequency for these items might have led the sign model to produce phonologically reduced signs, in which the HSs are harder to identify.

TABLE 7.

Accuracy (in %) per Group by Sign Type

Group	Core	CL	Nonce	Overall
Deaf	81	97	93	90
Non-Signers	69	89	89	83
Average	75	93	91	

In sum, these findings show that the Deaf signers process core signs and CLCs differently. These differences cannot be accounted for solely by differences in the formal characteristics of these signs since the non-signers did not display a similar pattern of response. There was no interaction with meaning for non-signers, as they were naïve to ASL. Further discussion of these results follows below.

Chapter 6

Discussion

The results of this study support the hypothesis. Deaf signers showed differences in RTs between the different sign groups; participants identified HSs in core signs the fastest, followed by nonce signs and CLCs. Non-signers displayed no difference in RTs between the sign types. These results imply that non-signers draw no distinction between sign types. This was expected, since having no knowledge of ASL or any other signed language, participants were solely focusing on their responses regarding HS. There was no interference of other sub-lexical processes for the non-signing participants. For the Deaf signers the implications are different. There are significant differences between their responses to the task for the different sign types. If the Deaf participants would have shown no differences in RTs between sign types, it could have been concluded that they are completing the task similarly to the non-signers. However, the implications are that the task was completed post-lexically by the Deaf signers. Post-lexical processing implies that there are other processes that are taking place, besides the monitoring on the phonological level.

Recognition of core signs is influenced by three factors: phonological parameter, frequency, and context. The differences between the sign types for the Deaf participants are significant. Core signs were responded to the fastest, followed by nonce signs, and CL signs. Since core signs are part of the core lexicon, they are the signs that participants are most familiar with. Thus, faster predictions are made by the signers regarding signs used within certain contexts. As an utterance progresses there is only a certain amount of possible signs that may occur in said utterance. Thus, signing participants were able to respond to the monitoring task the fastest for core signs.

For core signs the information for three of the four parameters, more precisely location, orientation, and HS, is immediately available at the sign onset. Movement, however, is not. Presumably, the sign onset activates multiple possible lexical candidates, similarly to the process in spoken languages. The candidates gradually become eliminated on the basis of the unfolding movement, as well as semantic context. Frequency and context may impact how much of the movement is needed before signers can be confident that they have recognized the sign accurately.

While the use of context to speed lexical access is well documented in spoken languages (Clark & Grosjean, 1982, Grosjean, 1980, Morford & Carlson, 2011), no previous monitoring study of a signed language has presented the targets in context. Thus, this is the first study which allows us to investigate lexical access when the influence of context is also contributing to the sign recognition. While in previous studies (Clark & Grosjean, 1982, Grosjean, 1980, Morford & Carlson, 2011) it was found that context facilitates semantic processing, it did slow participants in the present study relative to the previous studies, presumably because participants were more deeply engaging interpretive processing of the sentences while monitoring for HS. This provides additional support for the claim that the RT differences reflect lexical processing differences across core and classifier signs in interactive contexts, rather than superficial differences in the phonological form of these sign types. Deaf participants could not inhibit comprehension of the stimulus sentences before responding to the monitoring task for all sign types.

Frequency influences the recognition process such that frequent signs are recognized earlier in the sign form than infrequent signs. Thus, core signs are recognized earlier than CL signs, and before their production is completed.

Responses for nonce signs followed the same process. Specifically, context influenced the process, as well as phonology. However, since these signs do not exist in the ASL lexicon, signing participants could not anticipate the target signs. Similarly possible candidates are activated for nonce signs at the sign onsets, but as phonological input increases and the candidates are not consistent with sign input, all possible candidates get eliminated. Once the candidates are eliminated, participants will perform the monitoring task. Since participants had to wait for the movement and therefore the sign to be completed, the RTs are longer than for the core signs.

A similar thing happened when the Deaf participants were presented with the CLCs. The frequency of CLCs is very different than core signs in signed interaction. CLCs are highly unique constructions, they cannot be predicted. While sub-lexical components of CLCs, such as the HS, are frequently recurring, the constructions in which they occur are not. Full CLCs are much less frequent since the location and movement of CLCs are likely to change in order to “schematically represent the motion and location of objects" (Emmorey, 2002, p. 73). Since full CLCs are less frequent than core signs, then the sign onset may not be sufficient to activate multiple lexical candidates. Possibly only sub-lexical components of CLCs are activated by the sign onset. When used highly frequently, full CLCs are likely to lexicalize, undergoing phonological reduction, and entering the core lexicon. If lexical candidates are not activated by the sign onset of CLCs, then signers need to wait for the movement to be completed before they can interpret them. Thus recognition occurs later than for core signs. Therefore the responses to the CLCs in the monitoring task occur later, since the participants have to wait for the sign movement to be concluded before they may judge on the phonology and respond to the task.

In sum, Deaf signers displayed a different approach to the phoneme monitoring task than hearing non-signers. Though, in order to complete the task, meaning does not have to be accessed, Deaf signers do access meaning. They cannot simply “turn off” their semantic processing when presented with sentences and asked to respond to a HS. These findings support the findings of prior studies, though these studies presented isolated signs, rather than signs in context as the present study does (Corina & Hildebrandt, 2002; Morford & Carlson, 2011; Grosvald et al., 2012). Since the stimuli were presented within sentence contexts, a greater interaction of semantics and phonology could be observed.

For the future, it would be interesting to investigate why different HSs in the target signs influence results. Furthermore, investigation of hearing signers' performance on this task might provide us with a better understanding of differences or similarities between L2 learners and native signers. The results produced by this study help broaden the understanding of lexical processing with the addition of an insight to lexical processing of CLCs in ASL.

APPENDICES

Appendix A

Core Signs

HS:B	HS:1	HS:F	HS:V
GOOD	HAPPY	EXPERT	MEANING
SCHOOL	INJURY	VERY-CLOSE	RECKLESS
ALRIGHT	BORING	SOON	SAVE
NEW	MISS	CURIOUS	SALT
RELIEF	CONFLICT	KNOW-NOTHING	MISUNDERSTAND
FULL (food)	OPPOSITE	IMPORTANT	MEMORIAL
STOP	GOAL	JUDGE	TWO-DAYS-AGO
END	DIFFERENT	PERFECT	PREDICT
WALK	MEET	CAT	LOOK
CHILDREN	STARTS	INDIAN	TWINS
MOVIE	TEMPERATURE	OLYMPICS	FUNERAL
CITY	WEEK	VOTE	EITHER
WINDOW	PLUS	HAIR	TWO
BABY	TOOTH	EARRING	SMOKE
CORNER	BRUSH-TEETH	STRAW	SCISSORS
BOOK	EYES	BUTTON	WRENCH

Appendix B

Classifier Signs

HS:B	HS:1	HS:F	HS:V
CL:BB “dig”	CL:1 “ball fly far’	CL: FF “roll eyes”	CL:BV “ride horse”
CL:BB “fall in”	CL:11 “play drums”	CL: F “nose will grow”	CL:BV “jump”
CL:BB "bird wings"	CL:1 “rocket shot-up”	CL: F “pendant”	CL:BV “dive head-first”
CL:BB “doors close”	CL:1 “knife spin hit wall”	CL:FF “curved pipe”	CL:V “fork stab things on plate”

Appendix C

Nonce Signs

HS: B	HS:1	HS:F	HS:V
SAVE -BB	ENJOY-11	KEEP-FF	WORK-VV
VIDEOCHAT-BB	STAMP- H1-1	WORRIED-FF	NAÏVE-VV
AWKWARD-BB	COFFEE-11	WARNING- H1-F	SCARED-VV
HEADACHE-BB	SARCASTIC -11	PARANOID-FF	INVENT-VV

Appendix D

Participant Number: ____________

- -

The U.S. government collects the following information. The data are used to determine whether research represents all sexes and ethnicities. Your response is optional.

Sex: ___ Female ___ Male

Ethnicity: ___ American Indian or Alaskan Native ___ Asian
___ Black (not Hispanic) ___ Hispanic
___ Native Hawaiian or Other Pacific Islander ___ White (not Hispanic)

- -

Language Background Questionnaire Your age: ________

Which languages do you know? ____________________________________

List the languages you use the most in the order you learned them here:

	L1:__________	L2:____________	L3:_____________
Age of first exposure:	____ years old	_____ years old	_____ years old
Check the ones that you read:	____	_____	_____
speak/sign:	____	_____	_____
write:	____	_____	_____
Which do you use daily?	____	_____	_____
Weekly?	____	_____	_____
Which do you use at home?	____	_____	_____
at school?	____	_____	_____
at work?	____	_____	_____

Do your parents and/or guardians know these languages…

from birth? ____ _____ _____

as a second or third language? ____ _____ _____

Did they speak/sign these languages with you when you were a child?

____ _____ _____

If English is not your first language, how would you rate your English proficiency?

Beginner_____ Intermediate Low _______ Intermediate High _________

Advanced ______ Near native/Native _________

What is the highest level of education you have completed?

___ Less than high school grad
___ High School grad
___ GED
___ Some college courses
___ Associate's or Technical Degree
___ Bachelor's Degree
___ Some graduate courses
___ Master's Degree
___ Ph.D.
___ Other:___________________

For deaf participants only (check all that apply to you):

___ I have been deaf from birth.
___ I became deaf prior to age 3.
___ My uncorrected hearing loss is greater than 70 dB in the better ear.
___ I wear hearing aids.
___ I have a cochlear implant.
___ I have deaf family members.

How well do you understand oral English when you lip-read?

|____|

1 2 3 4 5 6 7 8 9 10

Hardly **Some** **Sufficient** **Well** **Perfect**

REFERENCES

Bosworth, R. G., & Emmorey, K. (2010). Effects of iconicity and semantic relatedness on lexical access in american sign language. *Journal of experimental psychology: Learning, memory, and cognition*, *36*(6), 1573-1581.

Brentari, D. (1998). *A prosodic model of sign language phonology*. Cambridge, MA: MIT Press.

Carreiras, M., Gutiérrez-Sigut, E., Baquero, S., & Corina, D. (2008). Lexical processing in Spanish sign language (LSE). *Journal of memory and language*, *58*, 100-122.

Clark, L. E. & Grosjean, F. (1982). Sign recognition processes in American sign language: The effect of context. *Language and Speech, 25*, 325-340.

Connine, C. M., & Titone, D. (1996). Phoneme monitoring. *Language and cognitive processes, 11*(6), 635-645.

Corina, D., & Hildebrandt, U. (2002). Psycholinguistic investigations of phonological structure in ASL. In R. Meier, K. Cormier & D. Quinto (Eds.), *Modality and structure in signed and spoken languages* (pp. 88-111). West Nyack, NY: Cambridge University Press.

Emmorey, K. & Corina, D. (1990). Lexical recognition in sign language: effects of phonetic structure and morphology. *Perceptual and Motor Skills, 71*, 1227-1252.

Emmorey, K. (2002). *Language, cognition, and the brain: insights from sign language research*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Grosjean, F. (1980). Spoken word recognition processes and the gating paradigm. *Perception and psychophysics, 28*(4), 267-283.

Grosjean, F. (1981). Sign and word recognition: a first comparison. *Sign Language Studies, 32*, 195-219.

Grosvald, M., Lachaud, C., & Corina, D. (2012). Handshape monitoring: Evaluation of linguistic and perceptual factors in the processing of American sign language. *Language and cognitive processes*, *27*(1), 117-141.

Morford, J. P. & Carlson, M. L. (2011). Sign Perception and Recognition in Non-Native Signers of ASL. *Language Learning and Development, 7*(2), 149-168.

Morford, J. P. & MacFarlane, J. (2003). Frequency characteristics of American sign language. *Sign language studies,* 3(2), 213-225.

Supalla, T. (1978). Morphology of verbs of motion and location. In F. Caccamise & D. Hicks (Eds.), *Proceedings of the second national symposium on sign language research and teaching* (pp. 27-45). Silver Spring, MD: National Association for the Deaf.

Williford, L. L. (2008). *Frequency of classifiers constructions in American sign language* (Doctoral Dissertation). University of Pittsburgh, Pittsburgh, PA.